MAGNETIC CONSTRUCTION MODULES FOR CREATING THREE-DIMENSIONAL ASSEMBLIES

Technical Field

The present invention is directed generally to puzzles and toys. More particularly, the present invention is directed to structural components having magnetic surfaces and which can be magnetically and/or mechanically coupled to form three-dimensional assemblies.

Background Art

Individuals often find enjoyment in the challenge of building aesthetic structural designs and/or functional structural models. Frequently, the utility associated with constructing such structures is found in the creative and/or problem solving process required to achieve a desired structural objective. Currently, construction assemblies that exploit magnetic properties to interlink various structural components and thereby form different two and/or three dimensional structures are known and can provide an

added dimension of sophistication to the construction process.

A significant shortcoming associated with the magnetic construction assemblies referred to above involves the inherently restrictive and at times penalizing design alternatives provided thereby. It is often the case, that these traditional magnetic construction assemblies have only a limited number of component parts, which parts typically have constrained geometries to ensure effective and suitably stable or secure connections. Thus, despite efforts to date, a need remains for a magnetic construction assembly that provides greater construction flexibility and/or design choice.

This and other needs/objectives are addressed by the present invention. Additional advantageous features and functionalities of the present invention will be apparent from the disclosure which follows, particularly when reviewed in conjunction with the accompanying drawings.

Disclosure of Invention

According to the present invention, structural components may be utilized to permit construction of a wide variety of structural profiles thereby increasing construction flexibility and/or design choice. The structural components of the present invention each include a number of magnets operatively associated with a periphery thereof to provide a number of points of magnetic connection. In addition, each structural component has at least one mechanical connector (e.g., a slot, and/or a slot and a magnet operatively associated with the slot) operatively associated therewith to provide at least one point of mechanical connection.

The present invention advantageously allows for two or more complementary structural components to be operatively connected via magnetic or mechanical connections to form a variety of different two or three-dimensional structural profiles of varying complexities. The present invention is advantageously suitable to magnetically cooperate with one or more ferromagnetic structures, such as a ferromagnetic or magnetizable ball or sphere, and/or an elongated rod

with magnet-equipped ends, to provide even greater design and construction flexibility.

Brief Description of Drawings

For a better understanding of the present invention, reference is made to the following detailed description of various exemplary embodiments considered in conjunction with the accompanying drawings, in which:

FIG. 1a is an elevational view of a structural component in accordance with one exemplary embodiment of the present invention;

FIG. 1b is a top plan view of the structural component of FIG. 1a;

FIG. 2a is an elevational view of a structural component in accordance with another exemplary embodiment of the present invention;

FIG. 2b is a top plan view of the structural component of FIG. 2a;

FIG. 3a is an elevational view of a structural component in accordance with still another exemplary embodiment of the present invention;

FIG. 3b is a cross-sectional elevational view similar to FIG. 3a showing a structural component constructed in accordance with another exemplary embodiment of the present invention;

FIG. 3c is a top plan view of the structural component of FIG. 3a;

FIG. 4 is a perspective view of two interconnected structural components in accordance with an illustrative embodiment of the present invention;

FIG. 5 is a perspective view of an exemplary construction profile in accordance with an illustrative embodiment of the present invention;

FIG. 6 is a perspective view of an exemplary construction profile in accordance with another illustrative embodiment of the present invention;

FIG. 7 is a perspective view of an exemplary construction profile in accordance with still another illustrative embodiment of the present invention;

FIG. 8 is a perspective view of an exemplary construction profile in accordance with a further illustrative embodiment of the present invention;

FIG. 9 is a perspective view of a primary connecting element operatively associated with a

secondary connecting element in accordance with another illustrative embodiment of the present invention;

FIG. 10 is a first plan view of the primary connecting element of FIG. 9;

FIG. 11 is a second plan view of the primary connecting element of FIG. 9;

FIG. 12 is a schematic plan view of a movable magnetic construction kit connecting element in accordance with another exemplary embodiment of the present invention;

FIG. 13 is a perspective view of a movable magnetic construction kit in accordance with another exemplary embodiment of the present invention;

FIG. 14 is an exploded perspective view of a module constructed in accordance with another exemplary embodiment of the present invention and including a rod and a pair of holders;

FIG. 15 is a schematic part-sectional side view of one of the holders illustrated in FIG. 14;

FIG. 16 is a schematic part-sectional side

view of a modified version of the holder illustrated in FIG. 15;

FIG. 17 is a side elevational view of a modified version of the rod illustrated in FIG. 14;

FIG. 18 is a side elevational view of another modified version of the rod illustrated in FIG. 14;

FIG. 19 is a perspective view of an alternate embodiment of a rod constructed in accordance with the present invention;

FIG. 20 is a perspective view of another alternate embodiment of a rod constructed in accordance with the present invention;

FIG. 21 is a perspective view of yet another alternate embodiment of a rod constructed in accordance with the present invention;

FIGS. 22a and 22b are broken away views of two modified versions of the rod of FIG. 21;

FIG. 23 is a schematic illustration of one type of mechanical connection between a holder and a rod according to the present invention;

FIG. 24 is a schematic illustration of another type of mechanical connection between a holder and a rod according to the present invention; and

FIG. 25 is a schematic illustration of yet another type of mechanical connection between a holder and a rod according to the present invention.

Best Mode For Carrying Out The Invention

Referring to the drawings and, in particular, FIGS. 1a and 1b, a magnetic structural component in accordance with a preferred embodiment of the present invention is shown and generally represented by reference numeral 10. As shown, the structural component 10 has a substantially square body 11 with two faces 12, 14 operatively associated with four edges 16, 18, 20, 22 and four corners 24a, 24b, 24c, 24d. The body 11 preferably has a predefined thickness "T" and at least one of the four edges 16, 18, 20, 22 has at least one mechanical connecting element 23 operatively associated therewith.

The mechanical connecting element 23, in a preferred embodiment of the present invention, is a

slot 34 located at the midpoint of the edge 20 with a predefined width "W". The predefined width "W" is preferably equal to or slightly greater than the thickness "T" of the structural component 10. The slot 34 preferably also has a predefined depth "D" extending in a direction at least substantially parallel to the edges 18, 22, preferably to half of the distance between the edge 20 and the edge 16.

The corners 24a, 24b, 24c, 24d are preferably biased at about 45 degrees and have at least one magnet 26a, 26b, 26c, 26d, respectively, operatively associated therewith. The magnets 26a, 26b, 26c, 26d are inserted permanently in each corner 24a, 24b, 24c, 24d of the structural component 10 with a surface 28a, 28b, 28c, 28d of each magnet exposed. The magnets 26a, 26b, 26c, 26d are preferably oriented so that the exposed surfaces 28a, 28b, 28c, 28d in adjacent corners (e.g., corners 24a and 24b) have opposite polarities to each other, indicated in FIG. 1a as N for north and S for south.

The structural component 10 may be fabricated from a solid plate 30 with pockets 32a, 32b, 32c, 32d in the respective corners 24a, 24b, 24c, 24d, formed by

molding or drilling the pockets 32a, 32b, 32c, 32d into the solid plate 30, or by some other method known in the art. Each pocket 32a, 32b, 32c, 32d preferably has a size and shape so that the corresponding magnet 26a, 26b, 26c, 26d can be inserted permanently into the respective pocket 32a, 32b, 32c, 32d. Each magnet 26a, 26b, 26c, 26d and its corresponding pocket 32a, 32b, 32c, 32d may be cylindrical, rectangular, or have some other shape, depending on the magnetic and/or mechanical connection type desired. As shown, the pockets 32a, 32b, 32c, 32d may be suitable to accommodate each magnet 26a, 26b, 26c, 26d so that the exposed surfaces 28a, 28b, 28c, 28d thereof are either flush or recessed with respect to the respective corners 24a, 24b, 24c, 24d in order to facilitate different connection characteristics. For instance, exposed surface 28a, as shown, is flush with respect to corner 24a, exposed surfaces 28b and 28d, as shown, are substantially recessed relative to the respective corners 24b and 24d, and exposed surface 28c, as shown, is only slightly recessed with respect to corner 24c.

By way of further illustration, the magnets 26a, 26b, 26c, 26d can be recessed in pockets 32a, 32b, 32c,

32d so that a beveled edge is formed enabling a connecting element (e.g., a ferromagnetic ball) to be both magnetically and mechanically connected to the module. Thus, by utilizing inherent magnetic and mechanical connecting properties, this magnetic/mechanical connection arrangement, as well as other similar arrangements, may advantageously provide for greater connection stability or performance.

Referring to FIGS. 2a and 2b, a structural component 10', in another embodiment of the present invention, is shown with a substantially triangular body 11'. In FIGS. 2a and 2b, elements corresponding to those of structural component 10 are indicated by like reference numerals with a prime symbol associated therewith. The triangular body 11' has two faces 12', 14' operatively associated with three edges 16', 18', 20' and three corners 24a', 24b', 24c'. The body 11' preferably has a predefined thickness "T'" and at least one of the three edges 16', 18', 20' has at least one mechanical connecting element 23' operatively associated therewith.

The mechanical connecting element 23', in this embodiment of the present invention, is likewise a

slot 34' located at the midpoint of the edge 20' so as to be diametrically opposite to the magnet 26b'. The slot 34' has a predefined width "W'" preferably equal to or slightly greater than the thickness "T'" of the structural component 10'. The slot 34' preferably also has a predefined depth "D'" extending in a direction at least substantially perpendicular to the edge 20', preferably to half of the distance between the edge 20' and the edge 16'.

Each corner 24a', 24b', 24c' is preferably biased at about 60 degrees and has at least one magnet 26a', 26b', 26c' operatively associated therewith. The magnets 26a', 26b', 26c' are preferably inserted permanently in each corner 24a', 24b', 24c' of the structural component 10' with a surface 28a', 28b', 28c' of each magnet exposed. The magnets 26a', 26b', 26c' are preferably oriented so that the exposed surfaces 28a', 28b', 28c' in adjacent corners (e.g., corners 26a' and 26b') have opposite polarities to each other, indicated in FIG. 2a as N for north and S for south.

The structural component 10' can be fabricated from a solid plate 30' with pockets 32a',

32b', 32c' located in the respective corners 24a', 24b', 24c'. The pockets 32a', 32b', 32c' can be formed by molding or drilling the pockets 32a', 32b', 32c' into the solid plate 30', or by some other method known in the art. Each pocket 32a', 32b', 32c' preferably has a size and shape so that the corresponding magnet 26a', 26b', 26c' can be inserted permanently into the respective pocket 32a', 32b', 32c'. Each magnet 26a', 26b', 26c' and its corresponding pocket 32a', 32b', 32c' may be cylindrical, rectangular, or have any other shape desired. Each of the pockets 32a', 32b', 32c', as shown, may be suitable to accommodate a magnet 26a', 26b', 26c' so that the exposed surfaces 28a', 28b', 28c' thereof may be either flush or recessed with respect to the respective corners 24a', 24b', 24c' so as to effectuate an improved connection via both mechanical and magnetic connection properties.

Referring to FIGS. 3a through 3c, a structural component 10'', in another embodiment of the present invention, is shown with a body 11'' substantially similar to that of body 11. In FIGS. 3a through 3c, elements corresponding to those of structural component 10 are indicated by like reference

numerals with a double prime symbol associated therewith. In this embodiment of the present invention, two identically shaped members, such as member 38'' of FIG. 3b, are preferably joined to form a hollow structural component 10'' having a similar arrangement of elements to the structural component 10. Each member 38'' preferably has half-pockets 40a'', 40b'', 40c'', 40d'', 40e'', 40f'', a slot 42'' and a raised edge 44'' integrally formed therein. The raised edge 44'' generally runs along the perimeters of the member 38'' and the slot 42'', except where it defines the half-pockets 40a'', 40b'', 40c'', 40d'', 40e'', 40f''. The two members 38'' may be joined by glue or by welding along their respective raised edges 44'', forming the hollow structural component 10'' having a central compartment 41''. The half-pockets 40a'', 40b'', 40c'', 40d'', 40e'', 40f'' on one member 38'' are aligned with and joined to the corresponding and complementary half pockets of a mirror image member to form pockets 32a'', 32b'', 32c'', 32d'', 32e'', 32f'' for insertion of the respective magnets 26a'', 26b'', 26c'', 26d'', 26e'', 26f''. An object, such as a label or decoration, may be placed within the compartment

41'' of the hollow structural component 10'' to enhance its appearance. The two at least substantially identical members 38'' may be formed in different colors or of different materials.

In other embodiments of the present invention, additional magnets may be operatively associated with the structural component 10, 10', 10''. For instance, as shown in Figs. 3a and 3b, a magnet 26e'' can be inserted permanently at the midpoint of an edge (e.g., edge 16'', edge 18'', and edge 22'') so that one surface 28e'' thereof is exposed. The exposed surface 28e'' may have either polarity N or polarity S. Further, a magnet 26f'' can be operatively associated with mechanical connecting element 23'' (e.g., slot 34'').

Having identified and described various embodiments of the present invention, in use, two or more structural components 10, 10', 10'' can be magnetically and/or mechanically interconnected to form any of a variety of construction profiles. For example, as shown in FIG. 4, two structural components (e.g., component 10 and component 10'' (as shown in FIG. 4), two instances of component 10, and/or two

instances of component 10'', etc.) may be mechanically connected by interlocking their respective slots 34, 34'' to form a three-dimensional cruciform assembly 50. In FIG. 4, corresponding elements of each structural component 10, 10'' have the same reference numerals, with the elements of structural component 10'' being differentiated from those of structural component 10 by use of a double prime symbol. With the foregoing explanatory comments in mind, each of the slots 34, 34'' of the structural components 10, 10'' slides completely over the faces 12, 14, 12'', 14'' of the other structural component 10, 10'' to create a cruciform assembly 50, in which the faces 12, 14'' of the two structural components 10, 10'' are oriented at least substantially 90 degrees to each other. The edge 16 of the structural component 10 preferably is flush with the edge 20''. Similarly, the edge 16'' of the structural component 10'' preferably is flush with the edge 20 of the structural component 10. The magnetic surfaces 28e, 28e'' of the respective structural components 10, 10'' are diametrically opposed to each other on the cruciform assembly 50.

Referring to FIGS. 5-8, a wide variety of assembled structures, ranging from the simple to the extremely complex, can be created by the imaginative user by combining cruciform assemblies 50, structural components 10, 10', 10'' and/or ferromagnetic balls 46. The structural components 10, 10', 10'' can also be combined with the wheel-like components discussed hereinafter with reference to FIGS. 9-13.

Referring to FIG. 5, an illustrative construction profile 55 may be formed by joining two cruciform assemblies 50, 50''' as shown. The cruciform assemblies 50, 50''', may preferably be joined at the magnetic surface 28e of the cruciform assembly 50 and the magnetic surface 28e''' of the cruciform assembly 50''', both magnetic surfaces 28, 28e''' being hidden in FIG. 5 by the cruciform assemblies 50, 50'''. The orientation of the cruciform assemblies 50, 50''' with respect to each other is maintained by the magnetic attraction of their respective corner magnets where the two cruciform assemblies 50, 50''' adjoin each other (e.g., magnet 26c of assembly 50 and magnet 26d''' of assembly 50''' are attracted to each other and magnet

26d of assembly 50 and assembly 26c''' of assembly 50''' are attracted to each other).

Referring to FIG. 6, another illustrative construction profile 60 may be formed by joining the structural component 10'', for instance, to the cruciform assembly 50. The slot 34'' of the structural component 10'' preferably engages the cruciform assembly 50 as shown and the structural component 10'' may preferably be held in place via a magnetic attraction, such as, for example, between the corner magnet 26b'' of structural component 10'' and the corner magnet 26c of cruciform assembly 50 and between the corner magnet 26c'' of structural component 10'' and the corner magnet 26b of cruciform assembly 50, both magnet 26c'' and magnet 26b being hidden in FIG. 6.

Referring to FIG. 7, a further illustrative construction profile 70 may be formed by attaching two cruciform assemblies 50, 50'', for instance, via magnetic attraction between the corner magnet 26d of assembly 50 and the corner magnet 26a'' of assembly 50'' and between the corner magnet 26c of assembly 50 and the corner magnet 26b'' of assembly 50'' (corner

magnets 26c and 26b'' are hidden in FIG. 7). The ferromagnetic balls 46, as shown, may be joined to corner magnet 26a of cruciform assembly 50 and/or, for example, to the end magnet 26e'' of the structural component 10'' as desired. Also, both magnet 26a and magnet 26e'' being hidden in FIG. 7, can be used as connectors to other structural components or cruciform assemblies as desired. For example, as shown, a structural component 10 may be mechanically connected to the crucifix assembly 50 via slot 34.

Referring to FIG. 8, an illustrative rotatable construction profile 80 can be created, for example, by magnetically connecting ferromagnetic balls 46 to magnets 26e, 26e''' operatively associated at opposite ends of the construction profile 55 of FIG. 5 (i.e., magnets 26e, 26e''' being hidden in FIG. 8). The construction profile 80 can be made to rotate freely while the ferromagnetic balls 46 are held stationary. For example, magnetic attraction/repulsion from nearby magnets can be used in conjunction with the rotating construction profile 80 to create a motor.

Referring now to FIG. 9, a primary connecting element in accordance with another illustrative

embodiment of the present invention is shown and generally represented by reference numeral 110. The primary connecting element 110, as shown, has an overall hub-like appearance with a disk-shaped, substantially planar body 112 having two faces, 111, 113, a number of primary magnets 114 operatively associated with a periphery or edge 116 thereof and at least one aperture 118 therein. In other embodiments of the present invention, the body 112 may have different shapes (e.g., polygonal, rectangular, etc.). As shown, the primary connecting element 110 is preferably operatively connectable with one or more secondary connecting elements 120. The secondary connecting elements 120 each have at least one secondary magnet 122 suitable for magnetically interacting with one or more of the primary magnets 114 associated with the primary connecting element 110. The primary magnets 114 of the primary connecting element 110 are preferably equally distributed with respect to each other. The polarities (i.e., north (N) or south (S)) of the primary magnets 114 are preferably staggered or oriented so that adjacent primary magnets 114 have different polarities, thereby providing optimal points of magnetic connection.

However, in other embodiments of the present invention, the primary magnets 114 and/or the polarities thereof need not be so arranged and may be distributed and/or oriented in a variety of different ways.

Referring to FIG. 10, the body 112 of the primary connecting element 110, in a preferred embodiment of the present invention, is a composite structure of a first half 124 and a second half 126 operatively connected via any known method for accomplishing such a task (e.g., adhesive, sonic welding, and/or other mechanical process). In this embodiment of the present invention, the first half 124 and the second half 126 are at least somewhat identical, and preferably substantially identical. The two halves 124, 126, together, may define a central compartment or cavity 127 suitable for accommodating an object such as a label or decoration (not shown). The first and second halves 124, 126 preferably cooperate to fixedly hold or retain the respective primary magnets 114 and prevent any unwanted and/or inadvertent disengagement thereof. For example, in one embodiment of the present invention, the first and second halves 124, 126 cooperate to form a number of magnet retaining pockets 128 about the edge

116 of the body 112. In other embodiments of the present invention wherein the body 112 is a solitary structure, the magnet retaining pockets 128 may, for example, be integrally formed in such solitary structure via a drilling or molding process.

The magnet retaining pockets 128 can have any of a variety of shapes, sizes and/or configurations. For instance, the magnet retaining pockets 128 can be cylindrical, square, rectangular, ovular, and polygonal or any other appropriate geometric shape. Preferably however, the magnet retaining pockets 128 are such that the corresponding primary magnet 114 accommodated thereby can be fixedly retained therein via any appropriate process or technique for accomplishing such an operation. For example, the magnet retaining pockets 128 and primary magnets 114 may be appropriately sized to cooperatively create a frictional bond of sufficient strength to prevent the inadvertent removal of the primary magnets 114. A suitable adhesive may also be utilized as appropriate to ensure a secure connection between the magnet retaining pockets 128 and the primary magnets 114. Still further, the respective magnet retaining pockets

128 can each have a retaining rim (not shown) for allowing effective receipt of the primary magnets 114 and preventing or at least substantially inhibiting the inadvertent removal thereof.

Referring to FIG. 11, in other embodiments of the present invention, different connecting arrangements may be utilized as appropriate to accomplish any of a variety of desired effects. For example, the magnet retaining pockets 128 can be configured to facilitate one or more primary magnets 114 being elevated a predefined extent ("E") with respect to an outer surface 130 of the edge 116. The respective primary magnets 114 can be elevated so that at least a portion of a top surface 132 thereof can make effective contact with, for example, the secondary magnet 122 operatively associated with the secondary connecting element 120. In addition, the respective primary magnets 114 can be accommodated by the magnet retaining pockets 128 so that the top surface 132 of such primary magnets 114 is substantially flush with respect to the outer surface 130 of the edge 116. Still further, the magnet retaining pockets 128 can facilitate one or more primary magnets 114 being recessed a predefined distance

("R") with respect to the outer surface 130 of the edge 116.

Still referring to FIG. 11, in an alternative embodiment of the present invention, the primary connecting element 110 can have one or more mechanical connectors, such as, for example, a protrusion 121, a recess 123, or a slot 125. Preferably, each mechanical connector is operatively connectable with a corresponding complementary connecting element. For example, the protrusion 121 may be well suited to cooperate with a secondary connecting element 120 having a complementary recess (not shown). Likewise, the recess 123 may be well suited for operatively connecting with a secondary connecting element 120 having a complementary protrusion (not shown). Further, the slot 125 having a predefined width W and depth D may be operatively associated with a secondary connecting element 120 having a complementary portion with the same or slightly less corresponding dimensions so as to be slidably received by the slot 125 as desired.

As may be recognized by those of ordinary skill in the pertinent art based on the teachings

herein, the identified mechanical connectors are only exemplary, however, and numerous other connectors that are currently or later become known for providing a stable connection between any of a variety of secondary connecting elements 120 and the primary connecting element 110 equally may be used. For instance, each mechanical connector can be provided with a unique surface structure or texture (not shown) to improve further the mechanical connection between the respective connecting elements.

Referring to FIG. 12, in another embodiment of the present invention, the primary connecting element 110 can operatively cooperate with one or more of the secondary connecting elements 120, one or more third connecting elements 136, and/or one or more fourth connecting elements 138 to form any of a variety of different construction profiles. For example, as shown, the primary connecting element 110 may be operatively associated with a number of circumferentially spaced, radially extending elongated secondary connecting elements 120. The elongated secondary connecting elements 120, which preferably have secondary magnets 122 recessed a predefined extent E in each end thereof as demonstrated in

FIG. 11, in turn, may each be operatively associated with a third connecting element. The third connecting element 136 may preferably operate as a flexible joint connecting two or more secondary connecting elements 120 distanced from the primary connecting element 110 so that the two or more secondary connecting elements 120 can be adjustably oriented in a variety of different directions relative to each other. For example, as shown, the third connecting element 136 can be a magnetically retainable, ferromagnetic or magnetizable ball or sphere of appropriate size to connect three secondary connecting elements 120 so that one element is radially oriented with respect to the primary connecting element 110 and the other two elements are at least substantially aligned with each other and, as shown, at least somewhat perpendicular with respect to the one element. Other arrangements would be readily apparent to one having ordinary skill in the pertinent art and equally may be used.

It should be noted that in an aspect of the present invention the spherical shape of the third connecting element 136 and the recessed secondary magnets 122 may allow for both a magnetic and a mechanical connection between each secondary connecting element 120

and the third connecting element 136. That is, a magnet may preferably be recessed with respect to the outer surface of a secondary connecting element a predefined depth (e.g., determined by the geometry of the third connecting element) so that a beveled edge is formed enabling the third connecting element to be both magnetically and mechanically connected to the secondary connecting element. This magnetic/mechanical connection arrangement may also be utilized with respect to the primary magnets 114 and pockets 128 of the primary connecting element 110. Accordingly, by utilizing both magnetic and mechanical connecting properties, this magnetic/mechanical connection arrangement, and other like configurations, may advantageously provide for greater connection stability or performance.

It is noted that it would be readily apparent to one of ordinary skill in the pertinent art based on the teachings herein that the third connecting element 136 can have any of a variety of other geometric shapes, sizes, or configurations suitable to effectively cooperate with at least the secondary connecting elements 120. For instance, the third connecting element 136, which, as previously noted, can preferably be made from a magnetizable material,

can have a non-magnetic cover (not shown) providing restrictive access to the magnetizable third connecting element 136. The cover can be suitable to facilitate any of a variety of different mechanical and/or magnetic connections.

Furthermore, the secondary connecting elements 120 can each be operatively associated with one or more fourth connecting elements 138, which preferably operate as a rigid joint connecting two or more secondary connecting elements 120 at a distance from the primary connecting element 110 and so that the two or more secondary connecting elements 120 are rigidly oriented in predefined directions with respect to each other. For example, as shown, the fourth connecting element 138 can be a curved member forming an elbow and connecting two secondary connecting elements 120 so that they are oriented at a predefined angle relative to each other. The fourth connecting elements 138 may be magnetically connected to the primary connecting element 110, the secondary connecting elements 120, the third connecting elements 136, and/or additional fourth connecting elements 138.

Referring to FIG. 13, in order to create dynamic movable magnetic construction profiles, one or more primary connecting elements 110 can be supported by an axle element 140. As shown, the axle element 140 preferably facilitates two or more primary connecting elements 110 to be operatively connected via the secondary connecting elements 120, the third connecting elements 136, and/or the fourth connecting elements to form any of a variety of construction profiles. The size and extent of such construction profiles is limited only by the relative magnetic strength associated with the magnets utilized with respect to the weight of the various connecting elements employed.

As shown, the axle element 140 preferably traverses the aperture 118 of each primary connecting element 110 supported thereby. The axle element 140 can have any of a variety shapes, sizes and/or configurations. Further, the axle element 140 may be permanently or detachably connected to a support surface 142. Still further, the axle element 140 can be operatively associated with an electro-mechanical device (not shown) for directly or indirectly providing an initial and/or continual work of movement force to any primary connecting

element 110 supported by the axle element 140. Alternatively, the axle element 140 can facilitate manually rotating any primary connecting element 110 supported thereby. In an embodiment of the present invention, once motion has been initiated, via manual or electrical means, such motion may be extended without continual manual and/or electrical aid for a specified time period by utilizing certain magnetic arrangements. For example, a first primary connecting element 110 and/or the secondary connecting elements 120 associated therewith may be positioned sufficiently close to a second primary connecting element 110 and/or the secondary connecting elements 120 associated therewith so that, in operation, once the first primary connecting element 110 is put into rotation, the second primary connecting element 110 is driven into motion by virtue of magnetic attraction between it and the rotating first primary connecting element 110.

Referring now to FIG. 14, another type of magnetic construction module 210 includes an elongated, cylindrical rod 212 and a pair of magnet holders 214, 216 attached to opposite ends 218, 220, respectively, of the rod 212. Each of the holders 214, 216 is adapted to be

releasably connected to the substantially rigid rod 212 in a male-female connection, so that in a complementary fashion one element has a male member and the other element has a female member adapted to receive the male member. In the exemplary embodiment of the invention shown in FIG. 14, the rod 212 is provided with the female members in the form of recesses 222, 224 in the ends 218, 220, respectively, while the holders 214, 216 are provided with the male members in the form of shanks 226, 228, respectively. More particularly, the shanks 226, 228 are releasably received within the recesses 222, 224, respectively, of the rod 212, whereby a user has the ability to interchange the holders 214, 216 with each other and/or with similar or dissimilar holders.

The holder 214 has a pocket 230 at the end opposite the shank 226, the pocket 230 being sized and shaped so as to receive a magnet 232. Similarly, the holder 216 has a pocket 234 at the end opposite the shank 228, the pocket 234 being sized and shaped so as to receive a magnet 236. The pockets 230, 234 can be formed in a variety of sizes, shapes and/or configurations so long as they are adapted to retain the magnets 232, 236, respectively. For example, the pockets 230, 234 can be

sized so as to frictionally retain the magnets 232, 236, respectively. Alternatively, the magnets 232, 236 could be bonded to the pockets 230, 234, respectively, with an adhesive. It should also be noted that while the pockets 230, 234 are especially adapted to retain the magnets 232, 236, the pockets 230, 234 may retain items other than magnets, such as Velcro, snap fasteners, etc.

With particular reference to FIG. 15, the pocket 230 is provided with a beveled edge 238, which projects beyond an exposed surface 240 of the magnet 232. The exposed surface 240, which may have any desired polarity (e.g., north or south), is adapted to establish a magnetic connection with either a magnet of another holder having an opposite polarity or with a spherical object 242, such as a metal ball, in which case the beveled edge 238 of the holder 214 adds a degree of mechanical support to the magnetic attraction between the spherical object 242 and the magnet 232.

Like the pocket 230 of the holder 214, the pocket 234 of the holder 216 is provided with a beveled edge (not shown) which projects beyond an exposed surface (not shown) of the magnet 236. Thus, like the magnet 232, the magnet 236 has an exposed magnetic

surface that is recessed relative to the beveled edge of the holder 216. The exposed surface of the magnet 236 is adapted to establish a magnetic connection with either a magnet of another holder having an opposite polarity or with a spherical object similar to the spherical object 242.

One advantage of the present invention is that the pocket 230 of the holder 214 can retain the magnet 232 in a recessed manner so that while the exposed surface 240 of the magnet 232 provides a magnetic connection to the spherical object 242, the beveled edge 238 provides a mechanical connection to the spherical object 242. More particularly, the beveled edge 238 substantially conforms to the surface contour of the spherical object 242, which is effectively seated in the beveled edge 238. In addition, the beveled edge 238 can be roughened, or otherwise adapted, to increase the coefficient of friction thereof. Still further, the exposed surface 240 of the magnet 232 can have a curvature which conforms to the surface contour of the spherical object 242, thereby improving the overall magnetic connection therebetween. Accordingly, by utilizing both magnetic and mechanical connecting properties, the present invention provides

greater connection stability and/or performance than known heretofore. It is noted that the spherical object 242 can be varied in size and need not be spherical, but can have any of a variety of other geometric shapes, sizes, or configurations suitable to effectively cooperate with the holder 214 and/or the magnet 232.

FIG. 16 depicts a holder 314 that is an alternate embodiment of the holder 214 shown in FIG. 14. Briefly stated, the embodiment of FIG. 16 operates in the same manner and provides the same advantages as the embodiment of FIG. 15, except that in lieu of a male member (i.e., the shank 226), the holder 314 has a recess 311 (i.e., a female member) that is adapted to receive a complementary male member provided on a rod (not shown).

As will be readily apparent to those skilled in the pertinent art from the present disclosure, the rod 212 of FIG. 14 may have any of a variety of other configurations, so long as it is adapted to have a male-female mechanical connection with complementary holders. FIGS. 17-21, 22a and 22b illustrate a few of these possible configurations and are briefly discussed hereinbelow.

For example, FIG. 17 illustrates an exemplary embodiment of a rod 412 that can be used in conjunction with holders like the holder 314 shown in FIG. 16. Whereas the rod 212 shown in FIG. 14 had recesses 222, 224 arranged at opposite ends, rod 412 has shanks 411, 413 extending from opposite ends thereof. Each of the shanks 411, 413 is adapted to be releasably connected within a complementary female member, such as the recess 311 of the holder 314 shown in FIG. 16.

FIG. 18 illustrates yet another embodiment of a rod 512 that can be used in conjunction with holders such as the holder 214 shown in FIG. 14, and the holder 314 shown in FIG. 16. Whereas the rod 212 shown in FIG. 14 had recesses 222, 224 arranged at opposite ends, the 512 rod has an end 518 with a recess 522 therein, and another end 520 with a shank 511 extending therefrom. The recess 522 of the rod 512 is adapted to be releasably connected with a complementary male member of a holder, such as shank 226 of the holder 214 shown in FIG. 14. On the other hand, the shank 511 extending from the rod 512 is adapted to be releasably connected within a complementary female member, such as the recess 311 of the holder 314 shown in FIG. 16.

FIG. 19 illustrates an embodiment of a rod 612 that is formed in the shape of a cross, whereby the rod 612 has four ends 611, 613, 615 and 617. The ends 611, 613 of the cross-shaped rod 612 have respective shanks 611a, 613a, each of which extends from the rod 612 and is adapted to be releasably connected within a complementary female member, such as the recess 311 of the holder 314 shown in FIG. 16. Conversely, the ends 615, 617 of the cross-shaped rod 612 have respective recesses 615a, 617a therein, each of which is adapted to be releasably connected with a complementary male member, such as the shank 226 of the holder 214 shown in FIG. 14.

FIG. 20 shows another variation regarding the structure of a curved rod 712, which is in the shape of an elbow having a predefined angle of curvature (e.g., 90 degrees). The curved rod 712 can be formed into elbows having angles less than or greater than 90 degrees according to need. In another aspect of the invention, (not shown), the length of the curved rod 712 could be adjustable by providing a hollow interior formed of at least two pieces having different diameters to permit a telescopic arrangement. The curved rod 712 has an end 713 with a shank 713a extending therefrom. The shank 713a is

adapted to be releasably connected within a complementary female member, such as the recess 311 of the holder 314 shown in FIG. 16. Conversely, the curved rod 712 also has an end 715 with a recess 715a therein. The recess 715a is adapted to be releasably connected with a complementary male member of a holder, such as shank 226 of the holder 214 shown in FIG. 14.

In a further exemplary embodiment of the present invention shown in FIG. 21, a rod 812, which has a pair of opposed ends 818 and 820, is formed from a bendable or flexible material made from a pliable, resilient material such as a soft metal, plastic or rubber material suitable to allow the rod 812 to be bent into any of a variety of curvilinear shapes. In this embodiment, a recess 822 is arranged in the end 818 of the rod 812 to releasably connect with a shank 826 of a holder 814 for a magnet 832. The end 820 may have a recess (not shown) or a shank (not shown), as desired.

FIG. 22a depicts yet another embodiment of the invention, wherein a rod 912a is shown having a pliable core 911, which can be made from any bendable material. FIG. 22b depicts a rod 912b, which is similar to the rod 912a except that the pliable core is in the form of a coil

spring 913, which can be made from any material suitable for retaining the shape of the rod 912b, as desired.

FIGS. 23-25 illustrate some of the variations regarding the releasable connection of the holder 214 to the rod 212. It is understood by an artisan that the variations in the type of releasable connection shown and described below can be applied to any of the different embodiments of complementary holders and rods previously shown and described.

FIG. 23 illustrates an example of a friction fit which is used to engage a shank 1026 of a holder 1014 (similar to the type shown in FIG. 14) within a recess 1022 of a rod 1012. The coefficient of friction associated with the outer surface of the shank 1026 and/or the inner surface of the recess 1022 may be adjusted by roughening as desired, via any known processes, of one or both of the mating surfaces. It is also understood and appreciated by an artisan that there is a variety of other mechanical connecting arrangements that can be used.

FIG. 24 is an illustration of a snap fit which is used to engage a shank 1126 of a holder 1114 (similar to the type shown in FIG. 14) within a recess 1122 of a rod 1112. In this embodiment, the shank 1126 has a boss

1113, while the recess 1122 has a complementary and corresponding groove 1115 to thereby prevent any inadvertent or unwanted release.

FIG. 25 is an illustration of the use of a threaded arrangement to engage a shank 1226 of a holder 1214 (similar to the type shown in FIG. 14) within a recess 1222 of rod 1212. In this embodiment, the shank 1226 has external threads 1213 that cooperate with complementary and corresponding internal threads (not shown) associated with the recess 1222. With this threaded arrangement, the holder 1214 and rod 1212 are connected by threading the shank 1226 into the recess 1222.

Although the invention disclosed herein has been described with reference to particular embodiments, it is to be understood that these embodiments are merely illustrative of the principles and applications of the present invention. It is therefore to be understood that numerous modifications may be made to the illustrative embodiments and that other arrangements may be devised without departing from the spirit and scope of the invention. For example, the planar structural components may be made

in other rectangular shapes than a square, or in shapes having a number of corners other than four, such as triangular or hexagonal shapes, or no corners, such as circular shapes. The slots may be formed so as to open at a corner of a planar structural component and extend inward at an angle to one or more edges of the structural component. The shape of the slot itself may be formed so that the planar surfaces of two interlocked structural components are oriented at some angle other than 90 degrees. In addition, the faces, edges and/or corners may be provided with any of a variety of textures and/or surface structures in order to effectuate construction of secure, stable structural profiles.